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CONTROL OF THE ARGENTINE ANT IN ORANGE GROVES

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SEVERAL VERY INJURIOUS scale pests of orange would be much more largely controlled by their insect enemies were it not for the Argentine ant.

This ant is very fond of the sweet substance, known as honeydew, excreted by mealybugs and other soft scales and is always very attentive to them and prevents many of their insect enemies from approaching them. Thus the natural enemies of these pests are hindered in carrying on their good work. As a result, some of the soft scales become excessively abundant.

The Argentine ant does not obtain honeydew from the armored scales, but in patrolling the trees constantly in large numbers in search of insect prey it hinders, to a certain extent, the work of the natural enemies of these scales, and if the control of the scales be neglected for several seasons the infestation may be considerably increased.

In Louisiana orange groves this ant can be controlled as an orchard and house pest by the trapping method described on pages 12–17. Once the orchard has been practically rid of ants, which can be done in from 8 to 10 fumigations of the trapped ants, little work will be needed to keep them from causing further annoyance.

In California orange groves the ants can be prevented from getting into the trees by banding the trees in accordance with the instructions on pages 19–20, and their numbers can be reduced by poisoning. Recipes for ant poisons and directions for using them are given on pages 17–19.

CONTROL OF THE ARGENTINE ANT[1] IN ORANGE GROVES.

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INTRODUCTION AND IMPORTANCE.

THE ARGENTINE ANT was introduced first into the United States on ships arriving at New Orleans from tropical American ports. It has been known in New Orleans for at least 25 years, and probably has been reintroduced many times during that period. It made its way from Orleans Parish into Plaquemines and St. Bernard Parishes, along the lower Mississippi River, by rail and on coal barges, and now occurs in slightly more than one-fourth of the orange groves of Louisiana. It has become established widely in California orange orchards, and is especially numerous in some orchards in Los Angeles and Riverside Counties.

This ant is of first importance as a pest in houses, groceries, and candy and meat shops. It not only causes great annoyance by persistently getting into all foods containing sugar, fats, or fruit juices, and into meat, but sometimes gets into beds and into the mouth and nostrils of infants. It probably ranks near to the house fly as a disease carrier, as it is a frequent visitor at feces and other sources of infection and doubtless often nests in contaminated soil.

It has been rated as a very important pest of field and truck crops, on certain of which it is said to cause great increase of mealybugs and aphids. Sometimes it removes the seeds of certain kinds of vegetables from the ground before they have germinated, necessitat-

[1] *Iridomyrmex humilis* Mayr.

ing resowing and protection of the seed. The ant also has been a pest at times in greenhouses, where it occasionally cuts into certain flowers and fosters mealybugs and aphids.

The general belief has been that in Louisiana the ant caused far more serious damage to the orange trees than to any other crop. It was thought to bring about a tremendous increase of all orange-infesting scales, white flies, and aphids, to destroy the blossoms and branches, injure the roots, greatly reduce the crop, and even kill the trees. In reality the ant is responsible for only one form of direct injury to orange trees. Rarely it chews into the petals and stamens of open orange blossoms for the purpose of squeezing out the sap. This occurs only on isolated trees, where food is scarce in comparison with the number of ants, and the amount of injury resulting is unimportant except on rare occasions. The ants habitually visit orange and other flowers to obtain nectar and to capture flower-feeding insects, but ordinarily do no damage to the flowers. The ant does not and can not injure sound oranges, although it enters and feeds upon the juice of broken ripe or rotting fruits.

The chief importance of the Argentine ant in orange groves is due to the fact that certain injurious scale insects become much more abundant as a result of its presence, and that it fosters mealybugs and aphids.

HOW THE PRESENCE OF THE ARGENTINE ANT FAVORS INCREASED INFESTATION BY SCALE INSECTS.

Two very distinct groups, or classes, of scale insects infest orange trees: (1) The armored scales, or those which settle permanently in a particular spot, lose their legs, and form a protective covering, such as a scale or shell, over the body. The eggs are deposited and the young hatch under the protection of this shell. The hard, flattened, apparently lifeless particles encrusting the branches and trunk and sometimes the fruit and leaves of orange trees are the armored scales. (2) The unarmored, or soft scales. These do not form a shell or scale over the body nor do they lose entirely their legs and the power of changing location. They are usually less flattened, softer, and, when mature, in most cases larger than the armored scales. Certain kinds, such as the mealybugs and the fluted scale, move about from one location to another throughout their lives. Others, such as the black, soft brown, and wax scales, usually settle down when partly grown and remain in one spot, though they are able to move about even in the later stages. The males of both classes of scale insects are minute gnatlike insects with wings.

The relations of the Argentine ant with the soft scales and aphids are direct and mutually beneficial. The ant is attracted to these insects for their honeydew, a sweet liquid which it induces them to

excrete by stroking their bodies with its antennæ, or feelers. The honeydew of soft scales, aphids, and some other insects forms an important part of the food of the ants. In securing this sweet excretion the ants continually surround the scales and aphids and attack any other insects that attempt to reach them. In this way they afford considerable protection to the scale pests and make it possible for certain species which have numerous and effective predacious enemies to thrive and increase to the point of causing severe infestations.

The Argentine ant does not obtain honeydew from the armored scales, but in patrolling the trees constantly in large numbers in search of insect prey it hinders to a certain extent the work of the natural enemies of these scales, and if the control of the scales is neglected for several seasons the infestation is increased considerably.

Contrary to the general belief, the ant does not itself distribute the scales and aphids of orange trees to start new colonies, although an occasional ant is seen carrying living scales or aphids, or scale shells, to the nest for flesh food and for nest construction. Of course, wherever the abundance of scale insects has become greatly increased through the presence of ants, a more rapid spread of the scales through the usual agencies, such as winds, birds, etc., naturally follows.

THE ANT AND SOFT SCALES IN CALIFORNIA.

Mealybugs.[1]—Infestations of mealybugs of the orange have been increased greatly in Los Angeles County, Cal., by the Argentine ant. In this county the orange trees usually are kept free from other scale insects and in vigorous health, and under these conditions, when protected from their numerous predatory enemies by the ants, the mealybugs are able to thrive. These natural enemies effect a practical control of the mealybugs in many Los Angeles County orange groves in the absence of the ant. As a result of the attendance of the Argentine ant, infestations of three or four species of mealybugs other than the common one are increasing in number and severity, particularly in the Pasadena district.

Fluted scale.[2]—The fluted or cottony-cushion scale is almost, if not quite, as eagerly sought and as closely attended by the Argentine ant as are the mealybugs, owing, no doubt, to the large amount of thick excretion which it supplies. At present, however, the ant can not be said to cause the slightest injury to orange trees in California through its relations with the fluted scale. Infestations of this scale become as severe at times in some localities, whether the ant is present or not, as when the insect was at the height of its abundance in earlier

[1] *Pseudococcus citri* (Risso) and other species of Pseudococcus.
[2] *Icerya purchasi* Mask.

years. During 1916, however, the insect was very scarce, even in the worst ant-infested orchards of Los Angeles, Riverside, and Ventura Counties, there seldom being more than one or two scales per tree. The chief factor in their control in California seems to be insect enemies, chiefly the Australian lady-beetle,[1] a parasitic fly,[2] and lace-winged insects;[3] but there appears to be some other unknown factor assisting.

Black scale.[4]—In California the black scale is rated as the most important of all the citrus scales. It is generally held in check by annual or biennial fumigation. Whether ants are in attendance or not, infestation by this scale often becomes very severe and capable of causing a heavy loss of crop after a single season in which fumigation has been neglected. Sometimes infestation is greater in trees where there are no ants than in others of the same age and condition overrun by ants. The black scale has quite a number of natural enemies, including one or two intermittently effective internal parasites, but these enemies do not seem capable of keeping it under control; hence interference by the ant with the work of these enemies does not accelerate greatly the increase of the scale.

Soft brown scale.[5]—The soft brown scale is a favorite of the Argentine ant. In Riverside County, Cal., this scale appears to have increased considerably in certain ant-infested groves, especially where for a long time fumigation has been neglected. Ordinarily it is controlled along with other scales by fumigation and no special treatment for the ant is needed. In Los Angeles and Ventura Counties both the soft brown scale and the closely allied citricola scale[6] are scarce in ant-invaded as well as in ant-free orchards. On more isolated ornamental trees, bordering some of the streets of Pasadena where the ants have become numerous, the scales are much more numerous than where there are no ants.

The control of scales by fumigation in California makes it improbable that the ant will increase seriously the damage from the black and soft brown scales in those orchards where fumigation is conducted regularly, although annual fumigation may become necessary in all groves invaded by the ants. The control of the mealybugs will be facilitated greatly, and in many cases accomplished fully, by the protection of the trees from ants. There are no present indications that the ants will cause the fluted scale to become again a menace to the State.

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[1] *Novius cardinalis* Muls.
[2] *Cryptochaetum monophlebi* Skuse. (Identified by Frederick Knab.)
[3] *Chrysopa californica* Coq. and possibly others.
[4] *Saissetia oleae* (Bern.).
[5] *Coccus hesperidum* L.
[6] *Coccus citricola* Campbell.

THE ANT AND SOFT SCALES IN LOUISIANA.

Mealybugs.—The ant has not had any such decided effect in increasing the severity of mealybug infestation in the orange groves of Louisiana as in those of California. The mealybugs usually start to increase rapidly in some groves of Louisiana in the spring and early summer and threaten to infest certain of them severely. But at some time between June 15 and August 1 they are brought under control by their natural enemies, regardless of the presence of the ants. The common mealybug[1] is at present held in check in the Louisiana orange groves partly by its natural enemies, partly by the overcrowding of the trees with armored scales and white flies, and partly by the poor condition of the trees. The insect does not cause the slightest damage to the orange trees, nor does it blemish the fruit, under present conditions in Louisiana.

Fluted scale.—The fluted scale never yet has been found in the orange groves of Louisiana, except in small and isolated plantings on the Metairie Ridge. It therefore may be dismissed with the citrus mealybugs as of no present importance as a cause of injury to orange trees in Louisana.

Black scale.—Although the black scale occurs in parts of New Orleans where the ants are most numerous, the ant has not yet caused any great increase of infestation there, and this scale has not come to the front as a pest, even of the ornamentals on which it occurs. It does not appear to be present in the orange groves proper of Louisiana.

Soft brown scale.—In the Louisiana orange groves the soft brown scale appears and disappears, being kept in check mainly by its internal parasites, against which the ants are relatively ineffective. The scales form in larger groups on occasional branches of an orange tree when attended by the ants than in cases where there are no ants. Occasionally trees are found having one or more small branches heavily infested, but even where the ants are most numerous the trees are not infested to a seriously injurious extent. The largest groups of soft brown scales occur on food plants other than orange trees in Louisiana.

From the foregoing it must be recognized that under present conditions very little damage is done to the orange industry of Louisiana by the Argentine ant through its relations with the unarmored, or soft, scales. Only four of the six principal kinds of orange-infesting soft scales occurring in this State have been found in the orange groves proper. At least two of these four, namely, the Florida wax scale[2] and the barnacle scale,[3] although attended by the ants, show

[1] *Pseudococcus citri* (Risso).
[2] *Ceroplastes floridensis* Comst.
[3] *Ceroplastes cirripediformis* Comst.

no likelihood of ever becoming dangerously numerous. The fluted scale may gain an entrance into the orange groves, and under ant attendance and other favorable conditions may become a serious menace. There is probably little to fear from the black scale under the climatic and other conditions which obtain in Louisiana.

THE ANT AND ARMORED SCALES.

The armored scales do not excrete honeydew or any similar liquid attractive to ants and, contrary to the general belief, are not attended by ants. They probably would become the prey of the ants if it were not for their protective shield, or scale. Ant shelters, or "cow sheds," sometimes occur over large and small groups of the armored scales, but the number of scales covered is so exceedingly small that it is unimportant. These shelters are erected for the protection of the ants and not for the protection of the armored scales. The ant does not disseminate any of the armored scales of citrus or colonize them upon new growth or new trees.

The ants eat all insects that they can capture except those supplying honeydew, and therefore they disturb certain enemies of the armored scales, and perhaps occasionally feed on the eggs of some of them. It therefore may happen that after two or three years of heavy and constant ant attendance, an orchard that is never sprayed or fumigated for the control of the armored scales may become more heavily infested by these scales than if ants were not present. Severe and injurious scale infestations may develop in a single year, in unsprayed orchards free from ants, as the natural enemies of the scales are not effective control agents. The injury caused by these scales, therefore, can not be prevented by destroying the ants. Direct control measures against these scales must be adopted and persistently practiced if orange growing is to be made profitable.

There are four important and destructive armored scales of orange trees in Louisiana—the purple scale,[1] chaff scale,[2] long scale,[3] and white scale.[4] The purple and chaff scales are by far the most numerous, generally distributed, and injurious, and for a long time have been among the leading citrus pests of Louisiana. The infestations of the armored scales are sometimes more severe where ants occur, sometimes more so where they do not, and are almost certain to be severe in untreated groves. These scales are more numerous on the present-day budded orange trees of Louisiana than they ever were in the seedling trees which formerly were common and which still are grown in large numbers in Cameron Parish, but this is due to the greater resistance of the seedling trees to scale infestation.

[1] *Lepidosaphes beckii* (Newm.).
[2] *Parlatoria pergandei* Comst.
[3] *Lepidosaphes gloverii* (Pack.).
[4] *Chionaspis citri* Comst.

The purple,[1] red, and yellow scales are the most important armored scales on citrus trees in California, but these usually are controlled in this State by hydrocyanic-acid gas fumigation, the results of which are not interfered with by the ants. Judging from present information the ants do not appear to cause excessive infestations of any of these scales in California.

THE ANT AND THE ORANGE APHIS.[4]

Notwithstanding the fact that the common aphis, or "green louse," infesting orange trees appears to be desired less by the Argentine ant than are the soft scales mentioned, it always is attended directly and stroked by the ant for its honeydew. This aphis, furthermore, should receive quite as much benefit as the armored scales from the mere occurrence of the ants upon the trees, but it suffers heavily from internal parasites, whereas scales do not. The ants are ineffective against these little parasites, which often may be seen "stinging" and depositing their eggs in aphids, even while attended by the ants. The parasites are very small and active and nimbly avoid the ants.

The orange aphis becomes abundant on the tender growth in the spring in both Louisiana and California, and often increases during April and May, sometimes causing some of the leaves to curl. It disappears rapidly, and numerous dried remains, each with a circular hole through which a parasite has emerged, indicate the effectiveness of these little enemies. The parasites are aided in the destruction of aphids by certain lady-beetles, lacewings, and syrphus-fly larvæ, which are more or less immune to the attack of the ants. The parasites, however, destroy a very large proportion of all the aphids, and very effectively control them in ant-infested as well as all other orange groves of California and Louisiana. The Argentine ant, therefore, does not cause any important loss to the citrus industry through the orange aphis.

THE ANT AND THE CITRUS WHITE FLY.[5]

The Argentine ant does not attend or obtain honeydew from the citrus white fly. It is a direct enemy of this insect, the adults of which it captures in large numbers during the principal emergence periods. The ant sometimes is seen with immature stages of the white fly in its jaws, but these are usually pupæ from which the adult insect is almost ready to emerge and which the ant impatiently has seized. A varying proportion of the emerging white flies are captured by the ants, and in some cases for days at a time

[1] *Lepidosaphes beckii* (Newm.).
[2] *Chrysomphalus aurantii* (Mask.).
[3] *Chrysomphalus citrinus* (Coq.).
[4] *Aphis gossypii* Glov.
[5] *Dialeurodes citri* (Ashm.).

more than half of the foraging ants will be seen carrying these insects down the trees.

The continuous patrolling of the trees by large numbers of ants must have the same disturbing effect upon predatory insects which may feed upon the white fly as upon those which prey upon the armored scales. Nevertheless, these enemies do not prevent extremely heavy white-fly infestation in orchards where there are no ants, whereas in groves in which ants are extremely numerous the amount of white-fly infestation often is small.

PREVENTION OF INJURY TO ORANGE TREES.

In Louisiana the damage resulting to the orange industry from the presence of the Argentine ant may be prevented largely by one or more of the following measures: (1) General improvement in orchard cultural practices, including the control of such orchard pests as the armored scales, the white fly, and the rust mite. (2) Direct measures for the destruction of the ant colonies and the use of ant barriers.

In California the means of preventing injury and controlling the ant are somewhat different. The armored scales are controlled by standardized methods of fumigation;[1] and other orchard practices also are standardized to some extent. Banding, as described on pages 19 and 20, to keep ants from ascending and descending the trees, and poisoning (see pp. 17–19), appear to be the most promising methods of control in that State.

BETTER ORCHARD CULTURE AS A PREVENTIVE OF INJURY IN LOUISIANA.

In Louisiana the first step toward preventing injury by the Argentine ant should be the control of the armored scales, through which most of this injury occurs, and the improvement of orchard practices in general. The destruction of the ants will not remove the necessity of controlling the armored scales and other principal pests, nor will it prevent injury due to faulty cultural conditions.

Orange growing in Louisiana never has received the care and attention that it merits, and it is capable of much greater commercial development than it has yet attained. In the earlier days citrus trees were grown there mostly for ornamental purposes or in small yard plots supplying only enough fruit for home consumption. Then followed small groves, almost exclusively of hardy seedling varieties largely resistant to insect pests, the fruit from which represented almost clear gain, no money having been expended to grow it, and the profits merely supplementing those from more important sources.

[1] See Farmers' Bulletin 923, "Fumigation of Citrus Trees," which may be had free on application to the Division of Publications, United States Department of Agriculture.

Most of the present plantings are budded trees set out since the great freeze of 1899, which killed to the ground every orange tree in the State. These trees are much more susceptible to injury from insects and other natural influences encountered in Louisiana than are the seedling trees. The nursery stock was largely of inferior quality, and the trees usually were planted too close together in shallow, wet soil, which encourages the roots to cover a great area close to the surface. The insect pests were allowed to flourish unchecked, all cultural care was neglected, and many of the trees were damaged further by floods, storms, and freezing. As a result a large proportion of them have remained undersized and in poor health. The amount of production has never reached that of normal healthy trees, and at from 7 to 10 years of age both trees and crop began to fail. The maximum production of Louisiana orange trees was but slightly more than three-fourths of a box per bearing tree, and the present production is only about one-half of a box per tree.

The success of certain well-tended orange groves in Louisiana demonstrates that oranges can be grown with profit in the State. The only commercially successful and profitable groves, however, have been those which receive an amount of care and attention much above the average for the State. The Argentine ant now occurs in slightly more than one-fourth of the Louisiana orange groves.

Comparison of the condition of the trees and the amount of the crop in ant-invaded groves with those in groves in which there are no ants shows that only about one-sixth more of the trees of the former are in poor condition than of the latter, while the average reduction in crop is only about one-fifth greater per tree in ant-invaded groves. This difference probably is due largely to the greater neglect of ant-infested trees because of discouragement at the invasion of the ant.

There are, of course, a number of groves in Louisiana that consist of trees of such poor quality and in such a run-down condition that they will never repay the cost of reclamation. There are others, however, that can be so improved by spraying, cultivation, and pruning that the production will be more than doubled in a single season and still further increased by continued treatment.

In Louisiana, therefore, the improvement of cultural conditions and the control of the armored scales, white fly, and rust mite, the principal injurious pests, are absolutely imperative if orange growing is to be made successful, even where the Argentine ant is not present. These insects can be controlled, even with the ant present, by following a properly arranged program of spraying,[1] and they can not

[1] For effective insecticides and directions for spraying, see Farmers' Bulletin 933, "Spraying for the Control of Insects and Mites Attacking Citrus Trees in Florida," which may be obtained free from the Division of Publications, United States Department of Agriculture.

be controlled by the destruction of the ant alone. Presence of the ants will not interfere with the control of these pests by spraying.

TRAPPING THE ANT IN LOUISIANA.

In Louisiana, owing to heavy annual rainfall, the ant colonies can be collected in specially constructed traps and destroyed, a thorough control thus being effected at moderate expense. Moreover, if this method be followed diligently, permanent control, which at the same time will eliminate the ant as a household pest, will be achieved. This is by far the best and most practicable means of destroying the Argentine ant in the orange groves of Louisiana.[1] It is the only method adapted to ant destruction in large groves and can be used equally well in house lots. The trapping method of destruction is based on the fact that the ants can be induced to concentrate in populous colonies in artificial nests to avoid rain and can there be conveniently killed by fumigation. The trap box meets every nesting requirement of the ant under Louisiana conditions. Not only are rains and cold excluded, but to a large extent draughts and light also. Larger numbers of ants will mass together in numerous small colonies than in a few

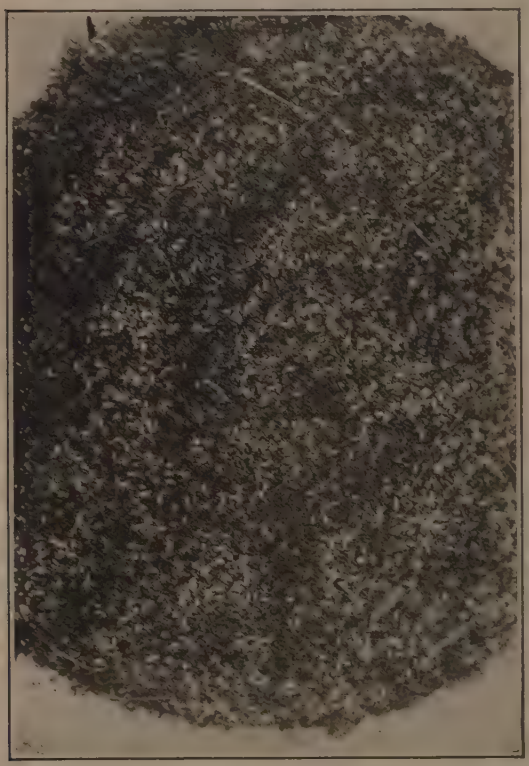

FIG. 1.—Average killing of Argentine ants in ant trap used in Louisiana orange groves.

[1] The discovery that the ants would nest in large numbers in boxes of decaying vegetation in winter was first made by Messrs. Newell and Barber, who describe a method of destroying them based on this fact. (See U. S. Dept. Agr. Bur. Ent. Bul. 122, p. 95–96.) The trapping method described in the present bulletin depends upon the nesting of numerous small colonies, that is, colonies averaging only from 100 to 160 queens each, in a specially devised trap box which excludes rain.

extremely large ones. The traps are therefore small and a rather large number per acre are used. An average-size mass of ants killed in one of these traps is illustrated in figure 1.

CONSTRUCTION AND COST OF TRAPS AND FUMIGATING COVERS.

The trap (figs. 2 and 3, A) is made of ⅞-inch sap pine and consists of the following nine pieces:

Two sides 12 by 12 inches.
Two sides 10 by 12 inches.
One bottom 10 by 10 inches.
Two top pieces 8 by 12 inches.
Two pieces triangular molding 12 inches long.

First the smaller sides and bottom are fastened together, then the larger sides added. Rosined nails or screws should be used in order to prevent separation at the seams and resultant enlargement of the box to a size too great for the fumigation cover. The top pieces are fastened together in the form of a gable with a tight joint, this roof merely resting, loose, upon the top of the box to exclude rain. The pieces of molding are nailed across the inner sides of the roof to hold it in place.

FIG. 2.—Trap used in destroying the Argentine ant in the Louisiana orange groves. (Note.—There should be only a single hole in the bottom to connect with the ant galleries under the trap.)

A cover to keep the gas in while fumigating is made of 28-gauge galvanized iron, consisting of one piece 38 by 13¼ inches, bent into two right angles, forming two sides and the top, and two pieces 13¼ by 13¼ inches, forming the other two sides. The edges of the latter two pieces are folded over those of the first piece and hammered tightly together. Covers with hammered seams are suitable if very well made, but soldered seams are to be preferred, although they may be slightly more expensive. The completed cover (fig. 3, B) should measure 12½ by 12½ inches inside, after a margin of one-fourth inch has been turned down all around the edge to reinforce it.

The cost of the traps, based on the price paid for 400 of them used in experimental work in 1914, would be about 31 cents each. The traps in question, made of C-grade sap pine, all parts cut to fit by the milling company furnishing the lumber, were supplied knocked down at 23 cents each, to which there was an additional charge of 8 cents each for transportation and setting up. The cost of the fumigating covers, based on the purchase of 48 of them in 1914, would be about 75 cents each, delivered.

PREPARING THE ORCHARD AND SETTING THE TRAPS.

The favorite rainy-weather nesting places of the ant are under loose boards, boxes, logs, sacks, and other loose pieces of cloth, and

FIG. 3.—Trap (A) and gas-tight cover (B) used in destroying the Argentine ant in Louisiana orange groves.

in piles of lumber or bricks, dead weeds, etc. The ants also nest in the walls of buildings when opportunity offers. They seek the higher, better drained ground in wet weather, and usually the larger colonies will be found on ditch banks and the high ground at the base of the trees.

In order to induce more rapid concentration of the ant colonies in the traps, the orchard as far as possible should be kept free from suitable natural nesting places. It should be cleared of loose boards and all similar materials under which the ants might collect. Piles of dry weeds, cowpeas, and prunings from the orange trees should not be allowed to collect in the grove, and stacks of lumber should

be set upon posts banded with the adhesive recommended on page 20, to keep the ants out. The grove should be clean cultivated, from March to September, by plowing and disking both ways of the grove three or four times during that period. Even the cover crops should not be grown during the first season of trapping, or until a very large part of the ants have been destroyed.

There should be at least 25 traps to the acre of 100 trees, and the destruction of the ants will be accomplished much more rapidly if twice that many are used. If 25 are used, one trap should be placed near every other tree in each direction. For example, starting with the first orchard row, set a trap near each of the first, third, and fifth trees, etc., throughout the length of the row, then similarly in the third, fifth, and seventh rows, etc. The traps should be located just under the outer spread of the trees, where they will not be in the way of the cultivator or so close to the tree that it will be injured by the carbon disulphid gas. At a distance of about 4 feet from the trunk the trap still will be on the tree hill and there will be no danger of injury to the tree from the fumigant. The trap should be placed upon a slight, level elevation made by throwing up and smoothing off a few shovelfuls of soil.

The number of covers necessary will depend upon the number of traps and the conditions of labor. In experimental work with 415 traps, 48 covers could be operated most economically in fumigating, as a crew of three could handle this number without loss of time between setting and removing the covers. Therefore the proportion of covers may be estimated roughly at 12 per 100 traps, or 3 per acre of 25 traps, where 300 or 400 traps are used.

In winter the traps should be filled with damp but not wet stable manure and dry weeds or straw, the manure occupying the lower half of the box. In summer the manure, which is used principally for its heat, may be omitted. Maggots of the house fly, and perhaps other insects which inhabit the manure, serve as an added attraction to the ants. It is important to keep the lids always on the traps, to keep out rain and darken the nest, and to help retain its warmth in winter. As rain is by far the most important factor in driving the ants into the traps, many more ants will be destroyed by trapping in summer than in winter.

METHOD AND COST OF FUMIGATING THE TRAPS.

When the traps are full of ants and ready for fumigation the lids are removed, 2 fluid ounces of carbon disulphid poured in, and the covers slipped on and banked with soil, one shovelful being tamped down at each side to help retain the gas. The traps must be fumigated for one hour. Two ounces of carbon disulphid per trap of 1 cubic foot capacity, for one hour, kills all stages of the ants in the traps and for 3 inches in the ground beneath, as well as worms, sowbugs, etc., inhabiting the soil.

Once fumigation is started, it should be completed in 4 or 5 days, or before possible dry weather may cause the ants to leave the traps. If the number of traps is small, one man can conduct the fumigation, but where there are 300 or 400 or more traps the work can be done most efficiently by a crew of three, one to carry and measure the insecticide while the other two remove and reset the covers and bank with soil. Such a crew, working continuously, can handle 48 fumigating covers, removing them from one lot of traps and placing them over the next in from 50 minutes to one hour. Three men can fumigate over 1,000 traps in 4 days.

The same trap filler may be used indefinitely, but it and the traps must be aired thoroughly after each fumigation. The filler should be spread out on the ground and the traps turned up to the sun for several hours before resetting.

The cost of installing and operating the ant traps, based on the prices prevailing in 1914–15, would probably run about as follows, per acre of 100 trees:

25 traps at $0.31 each	$7.75
3 covers at $0.75 each	2.25
Net cost of traps and fumigating covers per acre	10.00

In practice a crew of three have fumigated 400 traps in 1½ 8-hour days; their services, at the rate of $1.25 per day each, cost $5.62. The price of carbon disulphid prevailing in 1915 was $10.75 per hundred pounds. On this basis the cost of fumigation, with the use of 25 traps per acre of 100 trees, would be about as follows:

Cost of labor, fumigating 25 traps at $0.014 each	$0.35
Cost of insecticide, 25 traps at $0.013 each	.325
Net cost of fumigation per acre	.675

From five to eight fumigations about one month apart will be necessary to reduce the ants to an inconsiderable number in the orange grove.

USE OF DRAINAGE DITCHES TO PREVENT REINFESTATION.

The orange grove will be rid of ants more rapidly if reinfestation is prevented by means of barrier ditches. This means of preventing the spread of ants is well known in Plaquemines Parish, where some of the growers have adapted drainage ditches to this use. Where drainage ditches already have been dug around three sides of the orchard, as is the case in many orchards, they need only to be cleared of weeds and provided with divided bridges which ants can not cross (figs. 4 and 5) to adapt them for use against ants. On the lower land subsurface water will remain in the ditches practically throughout the rainy weather. In higher sections it will be necessary at times to flood the ditches with water from the river by means of rice-irri-

gating siphons. The water can be siphoned over the levee in the high-water stage, but must be forced over with gasoline engine and pump during the low stage. The ants spread very little by flight, but will travel far in the usual trails to nest in the traps, food usually being plentiful in the orange trees near at hand.

COOPERATIVE AND COMMERCIAL TRAPPING.

By cooperative trapping, in which all the landowners in a given section club together to purchase traps and insecticide, the ants can be destroyed more thoroughly and rapidly than if each one should undertake the work on his own account. Special crews could be trained to carry on the fumigation efficiently, and the cost of the

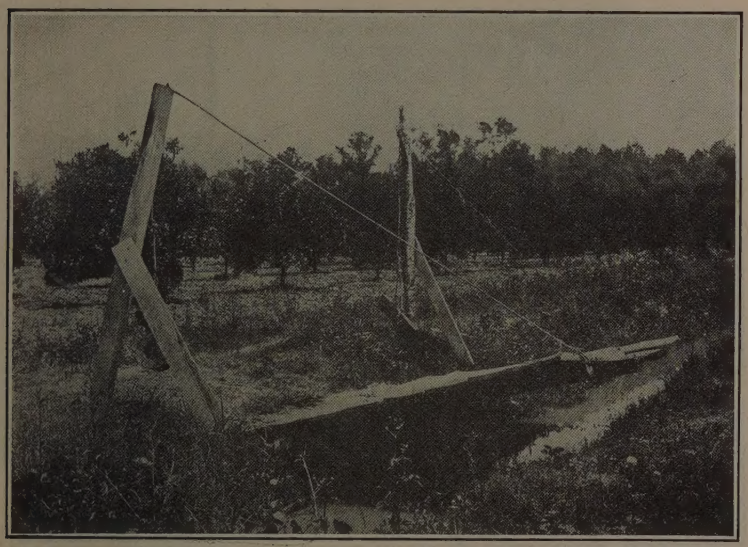

FIG. 4.—A bridge which the Argentine ant can not cross. (Newell and Barber.)

traps and insecticide would be reduced by purchasing in large quantity. The trapping method also might be put to use in southern Louisiana by commercial concerns, which could undertake to rid the land of ants at so much per acre.

USE OF POISONED BAITS[1] AND ANT BARRIERS.

POISONING THE ANTS.

Destruction of the Argentine ant by means of poisoned sirups and other baits in orchards where orange trees, weeds, and windbreaks or

[1] For a discussion of the control of the Argentine ant in the household, the reader is referred to Bulletin No. 377 of the United States Department of Agriculture, "The Argentine Ant: Distribution and Control in the United States."

borders of ornamental plants are left accessible to the ants is too slow and uncertain to be of practical value. Under such circumstances only a small proportion of the ants will be attracted from the natural sources of food in the trees and weeds, as they soon learn the injurious nature of the poison and ignore it, while continuing to feed at the usual near-by sources of supply.

It is absolutely necessary, therefore, if satisfactory results are to be obtained by this method, that all sources of food other than the poisoned bait be eliminated so far as possible. This involves clean cultivation and the banding of all trees, orange and ornamental, with a mixture that will keep the ants out. Tree-banding alone in some cases will cause a large proportion of the ants to migrate to another

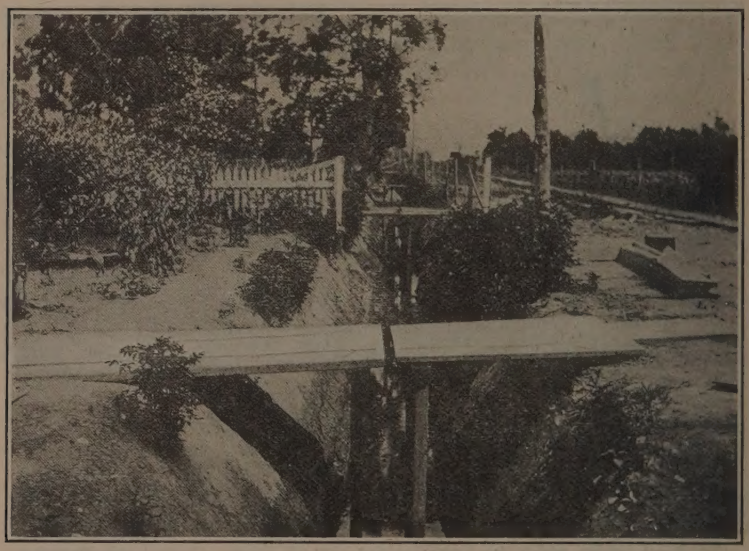

FIG. 5.—Bridges which the Argentine ants can not cross. (Newell and Barber.)

locality in search of food and, as long as maintained, will have the desired effect of preventing injury to the trees from the ants.

Although the employment of poisoned baits in accordance with the instructions given below often may prove practicable and effective in ridding yards where there are comparatively few trees infested by ants, this method can not be recommended for general orchard use in Louisiana as a substitute for the trapping method.

In preparation for the poisoning work, the premises should be first freed of weeds, long grass, vines, and other plants that can not be banded to keep out ants and that harbor aphids and scale insects. Then all the trees should be banded in accordance with the directions on page 19. The ant poison then should be distributed liberally

about the premises, in containers that will keep out rain. One-pint fruit jars, of the type illustrated in figure 6, are suitable for this purpose. A single hole is punched in the center of the lid for the admission of the ants. A piece of sponge is placed in each jar to aid the ants in reaching the poison. Scrap or waste sponges suitable for this purpose sell for about 25 cents per pound at drug stores, and 1 pound of them will serve for a dozen or more jars. About one-half pint of sirup will serve for each jar. The jars should be laid on their sides, and occasionally shifted to a new position.

The best poison is prepared as follows: Make a sirup by stirring 8 pounds of granulated sugar in one-half gallon of cold water until dissolved, making 1½ gallons of sirup. Then add 4½ ounces of chloral

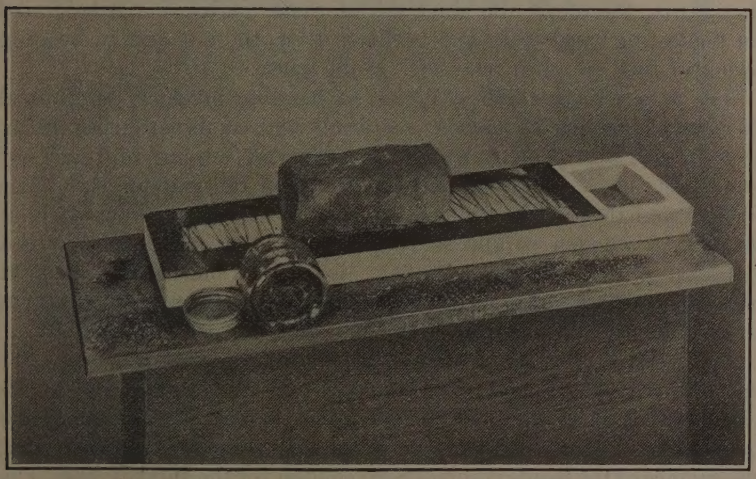

FIG. 6.—Artificial ant nest and jars used in poisoning the ants.

hydrate crystals, previously dissolved in a small quantity of water, and about one-half pound of strained honey. The honey will add to the attractiveness of the sirup.

If chloral hydrate can not be obtained, arsenite of soda may be substituted. Dissolve 62 grains of tartaric acid crystals in 3½ pints of water. Then add 8 pounds of granulated sugar and boil until dissolved. Allow to cool. Dissolve about 200 grains of arsenite of soda (or 172 grains of white arsenic) in one-half pint of hot water. When cool add to the sirup. Then add from one-half to three-fourths pound of strained honey. The tartaric acid prevents the souring of the arsenical sirup, which the ants will take very slowly.

USE OF TREE-BANDING MIXTURES.

In Louisiana orange groves the extensive use of adhesive and other repellent mixtures for banding tree trunks to keep out ants

is not recommended in view of the more positive method of destroying the ants by trapping. When used on a large scale, even the best bands of this sort will need more or less frequent inspection and renewal or respreading. Although the first cost of banding possibly might be less than that of installing traps, the cost of permanent maintenance would exceed the cost of trapping, and under present conditions would not be justified by the increased crop returns. Tree banding would cost more in Louisiana than in California, as in most cases an average of three bands would be required for every orange tree banded in Louisiana, owing to the growth habit of the trees. Furthermore, such barriers do not reduce the ant population, and therefore can not be considered a positive means of control. In Louisiana, therefore, the chief use of these mixtures will be found in protecting yard trees and beehives from the ant and in keeping it out of food supplies, beds, etc., in the house.

The most effective adhesive type of banding mixture, determined from much testing of various materials and combinations of them, is composed of 1 part by weight of flowers of sulphur to 6 parts of commercial tree adhesive. All the lumps in the sulphur should be broken and the two ingredients mixed thoroughly together without heating, a wooden paddle serving this purpose. The sulphur not only keeps the adhesive soft, but also has a sufficiently repellent effect upon the ants to prevent their bridging the bands with bits of trash or their own bodies.

Bands of this material will remain effective in rainy, foggy, or exceptionally dry weather for from three to five months, and in the cool weather of fall and winter as long as the ants are able to forage out of doors. If directly exposed to the sun for long periods, however, the surface of the bands becomes hard enough for the ants to cross. The bands, therefore, must be applied where the shade of the tree will protect them. The trees must be pruned so that branches will not touch the ground, and weeds must be prevented from touching the tree above the bands and allowing the ants to cross. The mixture should not be applied directly to the bark, as it would be absorbed to some extent and in time might injure the tree. First the trunk should be wrapped snugly with tire or hose-mending tape for a space about 6 inches wide, and then the adhesive should be applied over this in a band about 4 inches wide and one-fourth inch thick.

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